Evaluating Swab Sampling Efficiency of *Bacillus subtilis* Spores from Material Surfaces

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Abstract

To limit transport of terrestrial microorganisms to other planets via a spacecraft, the spacecraft components must be cleaned during the assembly process. Cleanliness must also be maintained throughout subsequent assembly and launch preparations. The procedure used to determine the bioburden on a spacecraft is described in detail in NASA Procedures and Guidelines 5304.1C. According to the procedure, a 25cm^2 area is randomly selected and sampled with a moistened cotton swab. The swab tips are vortex mixed and sonicated in water to dislodge the collected spores from the swabs. After heat shock, the solutions are cultured in TSA agar plates. The surface contamination is determined by counting the colony forming units on the cultured plates after three days. The efficiency of collecting samples from the spacecraft surface and the efficiency of releasing spores from swabs into solution had not been studied prior to this work. In this study, we have evaluated the sampling efficiency of three swab materials. Known amounts of *Bacillus subtilis* were deposited onto coupons of three commonly used spacecraft materials by using a Beckman Coulter Biomek robot dispenser. The coupons were dried before sampling. Three types of commonly used swabs were selected to sample the contaminated coupons. Our results show that between 10 to 30% of cultivable *Bacillus subtilis* spores can be recovered by the current swab collection method. However, we also found that only about 10% of the total amount of the spores deposited on the surface are cultivable. Therefore, the overall sampling efficiency based on the final CFU count is actually only 1-3% of the total spores deposited on the coupons. Further studies are needed to extend the investigation to other spacecraft materials, swab materials, and species of spores commonly found on spacecraft surfaces.